

How to receive a LRPT satellite image from METEOR-M2 with Multipsk Version 4.44 and "M2_LRPT_Decoder.exe"

1) Antennas and receivers

The ideal antenna seems to be the 137 MHz QFH one, but a Turnstile is very good also. A « V » antenna can also be used but it is not ideal at low angle. A vertical 144 MHz antenna can be also used successfully. However the Discone is not so good and is not recommended.

It can be used a "137 MHz LNA + filter" or a FM rejection filter, but it is not compulsory.

The receiver can be a SDRplay receiver, a Funcube dongle Pro+ or a RTL/SDR "V3" or equivalent (but the "V3" reception seems to be not so good as the SDRplay receiver).

Note 1: the FunCube Dongle Pro cannot decode the LRPT transmission because it samples at 96 KHz maximum, whereas the sampling frequency is 192 KHz for LRPT. Note that no information has been received, to date, about the good or bad working in LRPT, of the FunCube Dongle Pro+.

Note 2 : the LRPT signal is weak. It can be difficult to monitor the LRPT transmission with a sufficient signal-to-noise ratio. Its reception is a challenge. It is useless to listen to LRPT signal. It sounds noise.

2) "M2_LRPT_Decoder.exe" installation in the Multipsk directory

The pictures decoding must be made by the Oleg's program "M2_LRPT_Decoder.exe" Version 2015.7.1.033 minimum.

- For this, click on this WEB address ("AMIGOS"): <http://185.26.115.106/>
- Click on the "M2_LRPT_Decoder.exe (ver...)" link. This operation will download the "M2_LRPT_Decoder.exe" file. This file must be directly copied and pasted in the Multipsk directory.

3) Signal interface on Multipsk (« Configuration » screen)

For several SdR receivers as FunCube Dongle Pro+, RTL SDR or SDRplay, the I/Q signals will be directly demodulated by Multipsk.
Multipsk can also interface a VAC (Virtual Audio Cable) which would carry IQ data at 196 kHz / 16 bits / stereo, from a SdR application (for example SDRUno), itself in reception of a SDR receiver.

- First, control the **time on your PC**, for the Multipsk satellites monitoring. One method to set the PC clock is the following:
 - o run the "Clock" program ("little brother" of Multipsk), as Administrator,
 - o click on Internet time,
 - o select the time server DNS: "time.nist.gov",
 - o click on the "Connection" button. The PC has normally been set to the right time,
 - o close the Clock program.
- Start Multipsk. You are on the first screen (« Configuration » one),
- For a VAC, select the sound card (Input), push on the "**Direct via the sound card**" button in the « I/Q interfaces for Sdr transceivers » panel.
- For a Funcube Pro+, select the sound card (Input), push on the "**Direct via the sound card**" and "**FUNcube**" buttons in the « I/Q interfaces for Sdr transceivers » panel.
- For a RTL/SDR receiver, push on the "**RTL key/DLL**" button in the « I/Q interfaces for Sdr transceivers » panel, and wait for the receiver connection.
- For a SDRplay receiver RSP1(A), push on the "**SDRplay**" button in the « I/Q interfaces for Sdr transceivers » panel, and wait for the receiver connection. For the other SDRplay models, look at the Mike (KA3JJZ) WEB page: https://wiki.radioreference.com/index.php/Connect_the_SDRPlay_RSPs_via_TCP_IP_to_Multipsk

4) Preparation before LRPT reception on Multipsk (« RX/TX » screen)

- Click on the « **RX/TX screen** » button.
- Select the "**LRPT**" mode (on the bottom right of the modes panel).
- Received data can be sent to the decoding application "M2_LRPT_Decoder.exe", either by file or by a local TCP/IP link. By default, the "**To TCP/IP**" option is selected. So, "M2_LRPT_Decoder.exe" will be started automatically and you will see the image progressively appearing (it is the simplest).
Note, however, that the "**To file**" option permits to keep a file (time-stamped or not) of the pass. In this article, both options will be managed, but it is preferable to begin with the "**To TCP/IP**" option selected.
- For a SdR receiver interfaced with Multipsk, click on the blue « **QRGs** » button and then click on « **Forward** » to tune your receiver on the 137100 kHz frequency of the METEOR-M2 satellite.
- If the SdR is connected to Multipsk, click on the bold "**Transceiver**" button (top left of the RX/TX window). Adjust the gain avoiding preferably (if possible), "Auto" and "AGC". The goal is to have the global level displayed on the SdR

"I/Q direct interface..." window, not nil (several % of noise will be OK).

- If the SdR is connected to Multipsk, you can possibly see (for licensed users), for information, a 250 KHz spectrum around the LRPT frequency (look at the next picture), by clicking on the "**SdR spectrum**" button (top left of the RX/TX window).
- For the satellite follow-up over your home, click on "**Satellites**" (menu bar at the top of the window).
 - o Click on "**Personal**" and enter your position or Locator, if not already done.
 - o Possibly, click on "**Downloading**" to update the TLE file.
 - o Click on "**Pass predictions**" to see the next passages.
 - o You can use the "**Advance**" function to see where the satellite is going to pass.
- If the SdR is connected to Multipsk, there are two main possibilities of frequency control ("**Fr. Control**" panel):
 - o to remain with the absence of frequency control ("Fr. Control" panel) on "**No**", so the frequency reception will remain at 137100 Khz during all the pass,
 - o to select the "**HF**" option and leave the Doppler be directly corrected by Multipsk.

By default, there is no frequency control ("**Fr. Control**" on "**No**") proposed, so the frequency reception will remain at 137100 kHz during all the pass. The Doppler effect will be taken into account by the internal PLL. Perhaps, in case of very low signal, the "HF" option could be of some use.

Note about the receiver tuning and the Doppler drift: if the receiver is well tuned on 137.1 MHz, due to the Doppler drift, when the satellite, at the pass beginning, comes towards you, the apparent frequency will be about 137.1025 MHz. When the satellite gets away from you, at the pass end it will be about 137.0975 MHz. If it is over your home, it will be 137.100 MHz. To check the receiver tuning and the Doppler drift, the frequency locked by the PLL (phase-locked loop) is displayed below the "**PLL freq.**" caption. This frequency must be equal to about 2.5 kHz at the beginning of the pass and to about -2.5 kHz at the pass end. This indication permits to correctly tune the receiver.

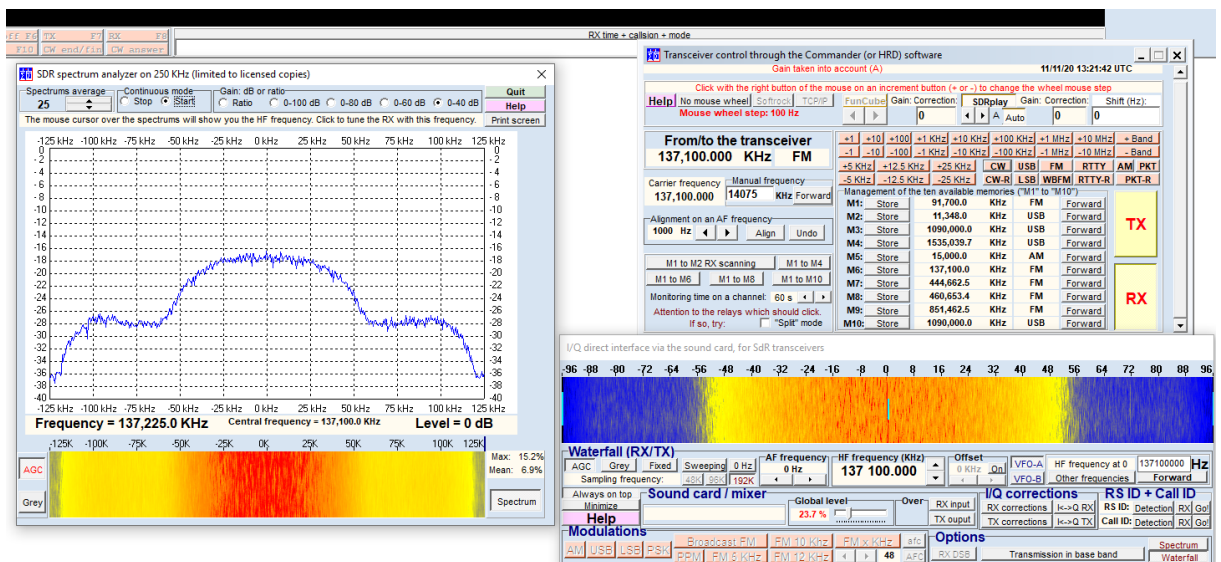
Note about an error message: when the "Satellites" window is open in LRPT, on few PCs and for an unknown reason, one or more error messages "Opération en virgule flottante incorrecte" can occur. They have no effect. Ignore them. Another solution is to open the satellites window in another occurrence of Multipsk (possibly in another PC), pushing on the "Stop demodulation" button to reduce the CPU load. Moreover, you can close the "Satellites" window once METEOR-M2 is visible.



- If the red caption "**Slow PC!**" pops up frequently, click on the "**Slow PC**" button. Under noise, your PC could be a bit slow (the LRPT demodulation needs much CPU), but on a true LRPT signal, it will be certainly sufficiently fast.
- Right click over any of the LRPT buttons, to see the LRPT manual. Look at the available LRPT commands and hints. You can also use the button hints (wait a fraction of second over a button to see the hint).
- Important: for a given receiver, the order of transmission of I/Q signals can be reversed (i.e. normal order I/Q or reversed order: Q/I). So at the first time LRPT is started, the I/Q order must be determined. That's why it is necessary to leave the "**Detection of an I/Q inversion**" function works at least once. A priori, RTL/SDR and SDRplay models, except the RSPdx, are reversed. Once the detection done for a given receiver, it is useless to do it at each LRPT starting up. In that case, to avoid this systematic detection, push on the "**Cancel**" button.

Now, you are ready for the next satellite pass.

5) Demodulation and decoding of the LRPT image

- Once the satellite is in direct view from your home (elevation angle superior to about 10°), you must see the two counters: the left one counting the number of « Synchronos » received and the right one determining the progress of the reception. A complete reception is obtained at about 95 %. 15 minutes of reception is the maximum, but 10 minutes is fine.
- See below a perfect signal received on the SdR waterfall (from Fred).



- The **square white picture** (above the AF waterfall), gives an idea of the received QPSK signal quality, showing the phase and the magnitude of signals. It must be seen four separated spots.
 - o For a very bad signal, it would be shown this:  The phase and the magnitude are almost random.
 - o For a very good signal, it would be shown this:  The 4 phases are well defined and the magnitude is almost constant.
 - o Often, the signal has an intermediate quality or it varies from one state to another.
- If the "**To TCP/IP**" option is selected, once the transmission received and the satellite disappeared, click on the "**Flush**" button to flush the last data received to the "M2_LRPT_Decoder.exe" program.

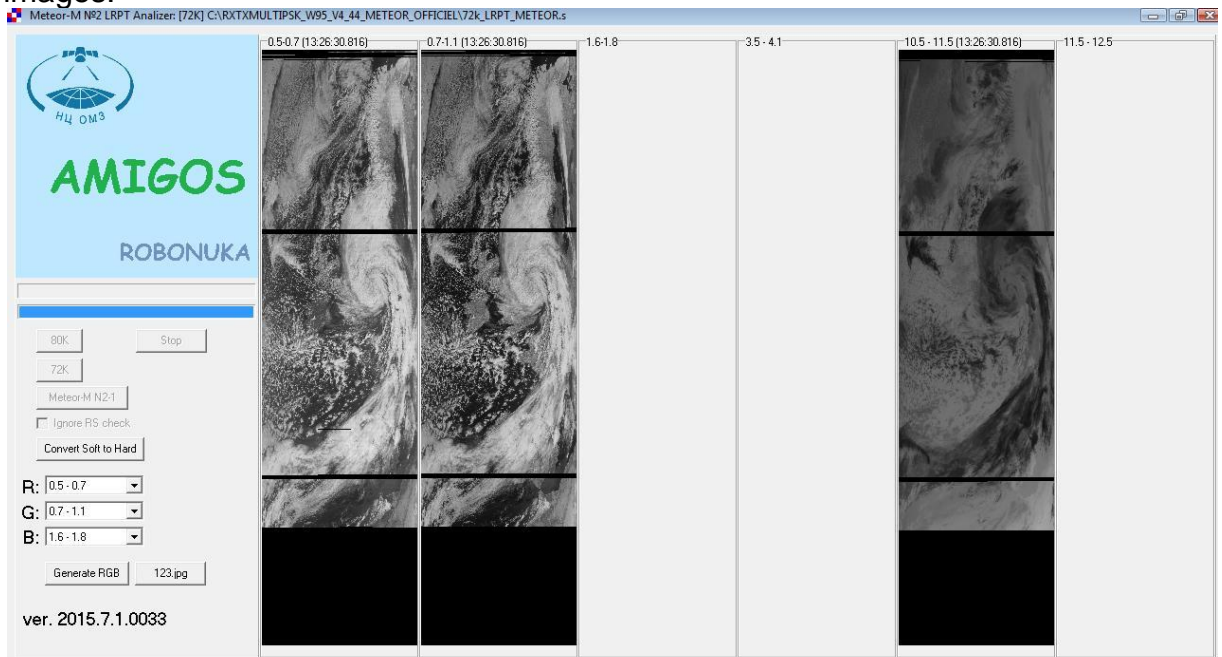
Note that if the "**To file**" option is selected, you must click on the « **Image decoding** » button, to decode the picture with the "M2_LRPT_Decoder.exe" program. On this program,

- o click on the "**72K**" button,
- o select the "**72k_LRPT_METEOR.s**" file. The LRPT image will appear.

Once the decoding finished (the inferior blue bar is alone), you must see the snapshot below.

Note that the three images are not the final images, but low resolution images used to follow the decoding progression.

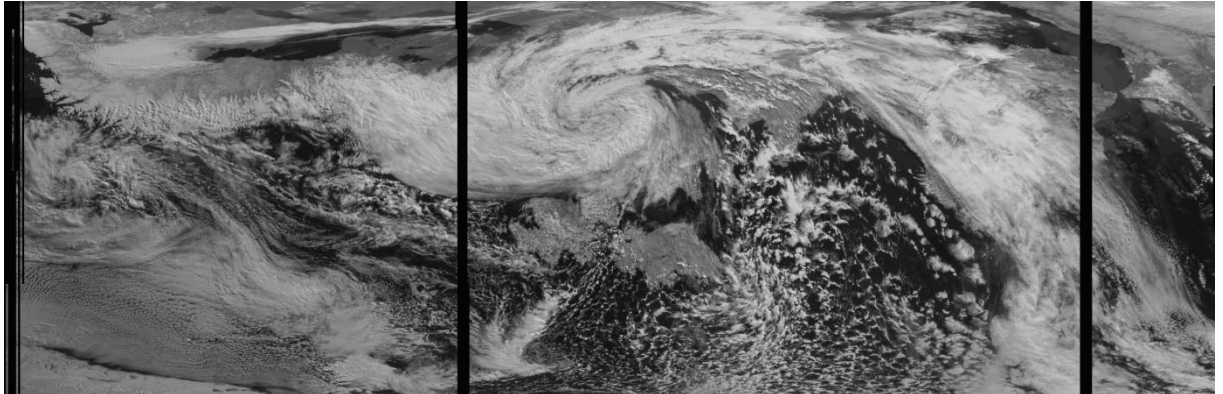
It appears normally 3 infrared images (as below) and rarely three standard images.



Note that it is difficult to have an image without any lines. They can be due to a weak level, distortions on the waves travel or the different processing operations (included Multipsk).

- Now click on the “**Generate RGB**” button, then on “**Save**”, select “**BMP**” and type on the “**Enter**” key. The pictures received (“72k_LRPT_METEOR.s_6*.BMP”) will be stored on the sub-directory “LRPT_pictures” of the Multipsk directory.
For example, it is shown below, the second image issued from the three images decoded by M2_LRPT_decoder.exe (from the snapshot above):

If the “**To TCP/IP**” option is selected, note that clicking on the “Stop” button of the “M2_LRPT_Decoder.exe” window, closes this application. So generate the images before clicking on “Stop”!



- Note that it exists programs to manage these pictures, to correct and transform them in false colors (and other functions). Here is a non-exhaustive list:
 - o Smoothmeteor: <https://leshamilton.co.uk/meteor3m.htm>
 - o MeteorGIS: <http://www.meteorgis.space/>
 - o LRPT Image processor: <https://www.satsignal.eu/software/LRPT-processor.html>

For example, below is displayed an extract from a picture received and corrected, by Josef (DE3JGA).

